# PHASED CONSTRUCTION OF NORTH DELTA INTAKE FACILITIES

## OCTOBER 12, 2011 WORKSHOP SUMMARY

### Background

The Delta Habitat Conservation and Conveyance Program (DHCCP) proposes to construct five intakes along the Sacramento River between Freeport and Courtland. However, considering the uncertainties associated with the construction and operation of five intakes along the river reach that is used by protected fish species for habitat and migration purposes, the Bay Delta Conservation Plan's Fish Facilities Technical Team (FFTT) produced a report which included a recommendation to develop a phased approach to implementing the construction of intakes[1](see Attachment 4). The goal of the phased approach is to reduce uncertainties of near-term and long-term impacts to fish species without requiring multi-staged permitting processes and Endangered Species Act (ESA) consultations. Phasing of intake construction would be an adaptive management approach with the implementation of the second phase being subject to the performance of the first phase. The draft proposal for the phased intake construction approach is included as Attachment 1.

Under the phased approach, the construction of north Delta intakes would be carried out in two phases. Prior to the construction of the first phase, a number of pre-construction studies (see Attachment 4) would be conducted and incorporated into the design of the first phase intakes. After the construction of the first phase intakes, a number of post-construction studies would be conducted for a period of 3 to15 years. The intent of the studies is to evaluate the impacts of the intakes on the overall survival of the targeted fish species that use the river for migration and habitat purposes. The studies would also determine if further design improvements are needed before constructing the second phase intakes.

### Workshop Objective

To better define the scope and schedule of the phased construction proposal the Department of Water Resources (DWR) sponsored a one day workshop in October 2011. The end result would be to include the phased approach proposal as a potential alternative in the ongoing Environmental Impact Report/Statement (EIR/EIS) process. The participants of this workshop included representatives from DWR, California Department of Fish and Game (CDFG), U.S. Bureau of Reclamation (Reclamation), U.S. Fish and Wildlife Service (USFWS), National Marine and Fisheries Service (NMFS), Water Contractors and consultants. The list of the participants is given in Attachment 2 and the workshop synopsis is given in Attachment 3. This memorandum presents a summary of the workshop findings. Also included in this memorandum are conceptual level construction schedules and cost estimates. These estimates were developed by DWR for each of the alternatives recommended by the workshop

[1] BDCP Fish Facility Technical Team Technical Memorandum, July 2011

participants.

## Conveyance Facility Assumptions

The participants noted that to realistically characterize the phased construction proposal, certain assumptions would have to be made regarding the location, capacity, and construction sequence of the proposed intakes, and the various conveyance options being analyzed in the EIR/EIS. For purposes of the workshop, the participants assumed that the conveyance facilities should include the tunnels, Pierson Tract Intermediate Forebay (PTIF), intermediate pumping plant and Byron Tract Forebay (BTF) as described in the Conceptual Engineering Report of the Pipeline/Tunnel Option (PTO CER)[2].

The workshop participants recommended the following assumptions be used to develop Phased Construction alternatives.

### 1. Intake Locations & Order of Intake Construction

The Phased Construction approach proposes constructing two intakes in the first phase followed by the construction of the remaining three intakes during the second phase. The FFTT has identified seven sites as possible intake locations, as shown in Figure 1 (blue triangles). Of the seven possible locations, the workshop participants selected intake 1 and intake 3 to be built during Phase 1. These sites were selected since they are located in deeper reaches of the river and have shorter screen lengths. Additionally, if DWR considers it to be advantageous to the overall schedule, the facilities at the backside of the levee at intake 2 could be constructed during Phase 1. Construction of the river side face of intake 2 and the full construction of the remaining two intakes would be carried out during the second phase.

### 2. Intake Capacity

The workshop participants agreed that 3,000 cfs was a reasonable diversion capacity of each intake. This intake capacity is consistent with the recommendation of the FFTT. With each intake diverting 3,000 cfs, the maximum diversion capacity after the completion of Phase 1 construction would be 6,000 cfs. After the completion of Phase 2, total build out capacity of the system would be 15,000 cfs provided that the Phase 1 intakes do not cause excessive impacts to protected aquatic species.

### 3. Conveyance Facilities Upstream of Intermediate Forebay

After the completion of the Phase 1 intakes, the water will be conveyed from intakes 1 and 3 to the PTIF using a combination of pipelines and a 23-ft diameter tunnel as proposed in the PTO CER. During Phase 1, some components of intake 2 would be built, including the shaft connecting intake 2 conveyance pipes with the 23-ft diameter tunnel. This will minimize the construction impact to the tunnel operation during construction of Phase 2 intakes.

### 4. Size and Location of the Forebays

[2] Conceptual Engineering Report – All Tunnel Option, DHCCP March 10, 2010.

The workshop team recommended construction of both forebays during Phase 1. The PTIF will have a maximum surface area of 750 acres. The downstream forebay (BTF) will be located on Byron Tract and will have a maximum surface area of 630 acres. This is the same as proposed in the PTO CER for the full build-out 15,000 cfs capacity diversion facilities.

### 5. Conveyance Downstream of Intermediate Forebay & Pumping Plant

The workshop participants recommended two possible options for conveying water from the PTIF to BTF. Under the first option, only one 33-ft diameter tunnel would be constructed during Phase 1 to convey water from PTIF to BTF. The maximum flow capacity of one tunnel under gravity is about 3,500 cfs, whereas the maximum diversion capacity of two intakes constructed during Phase 1 is 6,000 cfs. To transfer the 6,000 cfs from PTIF to BTF an intermediate pumping plant will be required. Thus, only half of the intermediate pumping plant will be constructed during Phase 1. The foundation and substructure of the complete intermediate pumping plant will also be constructed during Phase 1.

In the second option both 33-ft diameter tunnels would be constructed during Phase 1. The maximum flow carrying capacity of two tunnels under gravity is about 7,000 cfs, which is higher than the maximum diversion capacity of two intakes (6,000 cfs). Therefore, the intermediate pumping plant will not be constructed during Phase 1 under this second option. However, the foundation and substructure of the intermediate pumping plant will be completed during Phase 1.

### 6. Remaining Facilities

Irrespective of the chosen conveyance option for the downstream conveyance connecting PTIF to BTF, the flow control gates at PTIF, the switchyard and all communication devices will be constructed during Phase 1.

## Phased Construction Alternatives

Using the assumed project components, the workshop participants developed six alternatives for the phased approach to intake construction. The alternatives are summarized in Table 1. The baseline referred to in Table 1 identifies the components that are consistent amongst all the alternatives, as a starting point that all the alternatives were derived from. The major components to the baseline condition include constructing 5 intakes under all alternatives at a maximum diversion capacity of 15,000 cfs, where all alternatives would have a pre- and post- construction study period included.

**Table 1: Alternatives for Phased Approach to Intake Construction**

| Alternative | Alternative Description and Major Components** |
|---|---|
| **Baseline** | Pre- and post-construction studies, construction of 5 intakes and 15,000 cfs maximum diversion capacity as proposed in PTO CER. |
| **Alternative 1** | **Phase 1:** Construction of intakes 1 and 3 [Optional Construction of |

| | |
|---|---|
| | intake 2 facilities up to back side of the river levee *]; Conveyance pipe connecting intakes 1 and 3 to 23-ft diameter conveyance tunnel; [Optional Construction of connecting shaft from intake 2 to 29-ft diameter conveyance tunnel]; PTIF and BTF; Canals and flow control gates to take water from BTF to state and federal export pumps; One 33-ft diameter tunnel from PTIF to BTF; Connector for a second tunnel from PTIF; Gravity bypass gates for 6.000 cfs; Switchyard; Communication devices; ½ of the intermediate pumping plant; Foundation and substructure of remaining half of pumping plant<br>**Post-construction Study Period:** 3 years<br>**Phase 2:** [Construction of water side of intake 2*]; Construction of remaining intakes; Pipelines/tunnel connecting remaining intakes to PTIF; Completion of intermediate pumping plant; Second 33-ft diameter tunnel from PTIF to BTF |
| **Alternative 2** | **Phase 1:** Same Alternative 1<br>**Post-construction Study Period:** 15 years<br>**Phase 2:** Same Alternative 1 |
| **Alternative 3** | **Phase 1:** Same as Alternative 1 except: Two 33-ft diameter tunnels from PTIF to BTF; Foundation and substructure of the intermediate pumping plant without installing pumps.<br>**Post-construction Study Period:** 3 years<br>**Phase 2:** [Construction of water side of intake 2*]; Construction of remaining intakes; Pipelines/tunnel connecting remaining intakes to PTIF; Completion of intermediate pumping plant |
| **Alternative 4** | **Phase 1:** Same as Alternative 3<br>**Post-construction Study Period:** 15 years<br>**Phase 2:** Same as Alternative 3 |
| **Alternative 5** | **Phase 1:** Same as Alternative 1<br>**Post-construction Study Period:** 3 years<br>**Not allowed to proceed with Phase 2 construction** |
| **Alternative 6** | **Phase 1:** Same as Alternative 1<br>**Post-construction Study Period:** 15 years<br>**Not allowed to proceed with Phase 2 construction** |

* The DOE timeline/costs assumed that the optional construction of intake 2 facilities to the backside of the river levee is included in Phase 1.
** Pre-construction studies have also been identified by FFTT (2011) as necessary, but are not shown-in the table above. The pre-construction study period could last up to 2 years, with continued on-going studies thereafter. After the completion of the intakes the post-construction studies will be continued for all of the alternatives as identified by the FFTT (2011), including the baseline.

## Construction Duration and Cost

For each alternative, the conceptual level construction schedule and cost were prepared by DWR for comparison purposes. The construction timelines were compiled from the May 2010 Isolated Conveyance Facility- East Schedule (for intake, intake pumping plant, intermediate pumping plant, and BTF construction times), the November 2009 PTO Schedule (for intake pipe connections and PTIF construction times), and Appendix J of the December 2010 Tunnel Optimization Report (for tunneling construction times). The construction time line were developed by assuming that all of the environmental permits, certifications, and permission's required to begin construction will be obtained as required before the start of the construction. The post-construction study period for intakes constructed during Phase 1 is anticipated to be between 3 to 15 years. It was assumed that the construction of Phase 2 intakes and other remaining components will take place only after the completion of the post-construction studies.

A summary of construction durations for the Baseline facilities (full build out) and the Phased Construction alternatives is given in Table 2 and also graphically shown in Figure 2. It is assumed that the design of the facilities in Phase 1 or Baseline and the studies take place concurrently and before year zero. The design for Phase 2 is performed concurrently with the studies. Breakdowns of the construction times are given in Figures 3 through 5. The construction duration for the Baseline facilities is about 7.25 years, assuming all of the components are constructed simultaneously. For each individual intake, construction duration of 7.25 years would be required with the controlling factor being the time required to manufacture and install the pumps. With a 3 to 15 year study period, the total construction and study duration for the remaining alternatives vary from 10.25 years to 29.5 years.

**Table 2: Construction Durations under the Various Phasing Alternatives**

| Phasing Alternative | Activity Duration (years) | | |
|---|---|---|---|
| | Phase1* | Post-construction Study Period | Phase 2 |
| Baseline | 7.25** | | |
| Alternative 1 | 7.25 | 3 | 7.25** |
| Alternative 2 | 7.25 | 15 | 7.25** |
| Alternative 3 | 7.25 | 3 | 7.25** |
| Alternative 4 | 7.25 | 15 | 7.25** |
| Alternative 5 | 7.25 | 3 | - |
| Alternative 6 | 7.25 | 15 | - |

*Pre-construction studies have also been identified by FFTT (2011) as necessary, but are not shown-in the table above. The pre-construction study period could last up to 2 years, with continued on-going studies thereafter.

** After the completion of the intakes the post-construction studies will be continued for all of the alternatives as identified by the FFTT (2011), including the baseline.

The construction costs were derived from 5RMK[3] cost estimates for the PTO CER. Some of the assumptions used in deriving the preliminary cost include:

[3] BDCP-All Tunnel Option Summary Estimate, 5RMK, Inc., February 24, 2010.

- A annual rate of cost escalation of 5.0% per Budget Letter BL 10-15[4].
- In addition to the 5RMK, Inc. management costs, contingencies (25% of applicable construction costs), land/ROW costs (15% of applicable construction costs), and management/design costs (18% of construction + contingency + land/ROW) were added to all phasing scenarios for the whole project or for Phase 1 and Phase 2 individually.

There will be some costs associated with the post-construction studies as proposed by the FFTT (2011). However, considering the uncertainties regarding the scope of the studies, no dollar values have been assigned for these studies at the time of this workshop. The DWR/DOE is pursuing with the other agencies to develop estimates of the costs associated with implementing the post-construction studies. The estimated construction costs are shown in Figure 2. The construction cost for the Baseline (full build out) facilities is about $12.9 billion in 2011 dollars. For the phased alternatives, the construction costs correspond to the escalated construction cost at the start of the respective construction phase. If the construction of the second tunnel is postponed as proposed in Alternatives 1 and 2, the total construction cost for Phase 2 components will be $9.6 billion and $17.2 billion, respectively. The higher construction cost of Phase 2 construction for Alternative 2 is due to the 15 year long testing and study period associated with the alternative. If both of the tunnels are constructed during the Phase1 of the project as proposed in Alternative 3 and 4, the total construction cost for Phase 2 components will be $2.5 billion and $4.5, respectively. The higher construction cost of Phase 2 construction for Alternative 4 is due to the 15 year long testing and study period associated with the alternative.



**Diversion Delivery Impacts**

The average annual diversions from the north Delta Intakes are shown in Figure 2. The average annual diversion from the Baseline (full build out) facilities is about 2,928 TAF[5]. After the construction of the Phase 1 intakes, the average annual delivery from north Delta Intakes is about 2,090 TAF. Since the yield from Phase 1 intakes is less than that of the yield from the Baseline facilities, the balance of the delivery will be made from existing south Delta facilities. In the case of major flood, earthquake or sunny day failures of the Delta levees, the annual delivery from the south Delta facilities is expected to be unavailable and the export would decrease by about 838 TAF annually.

[4] Budget Letter BL 10-15, Escalation of Construction Costs for State Funded Capital Outlay Projects, California Department of Finance, July 12, 2010.
[5] November 2010 CALSIM Study Runs for the Baseline Alternative.

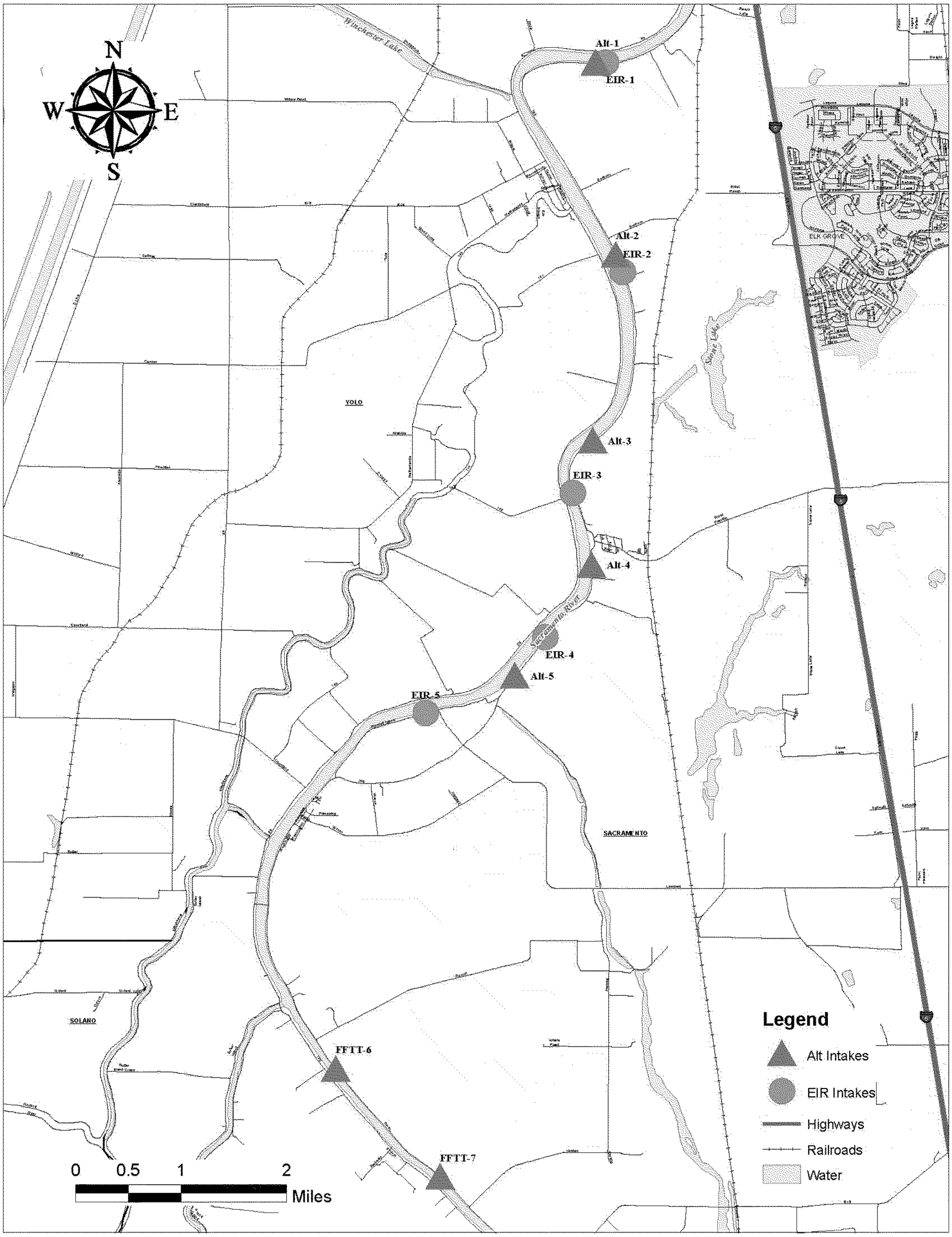


**Figure 1: Potential North Delta Diversion Locations Reviewed by the FFTT (2011)**

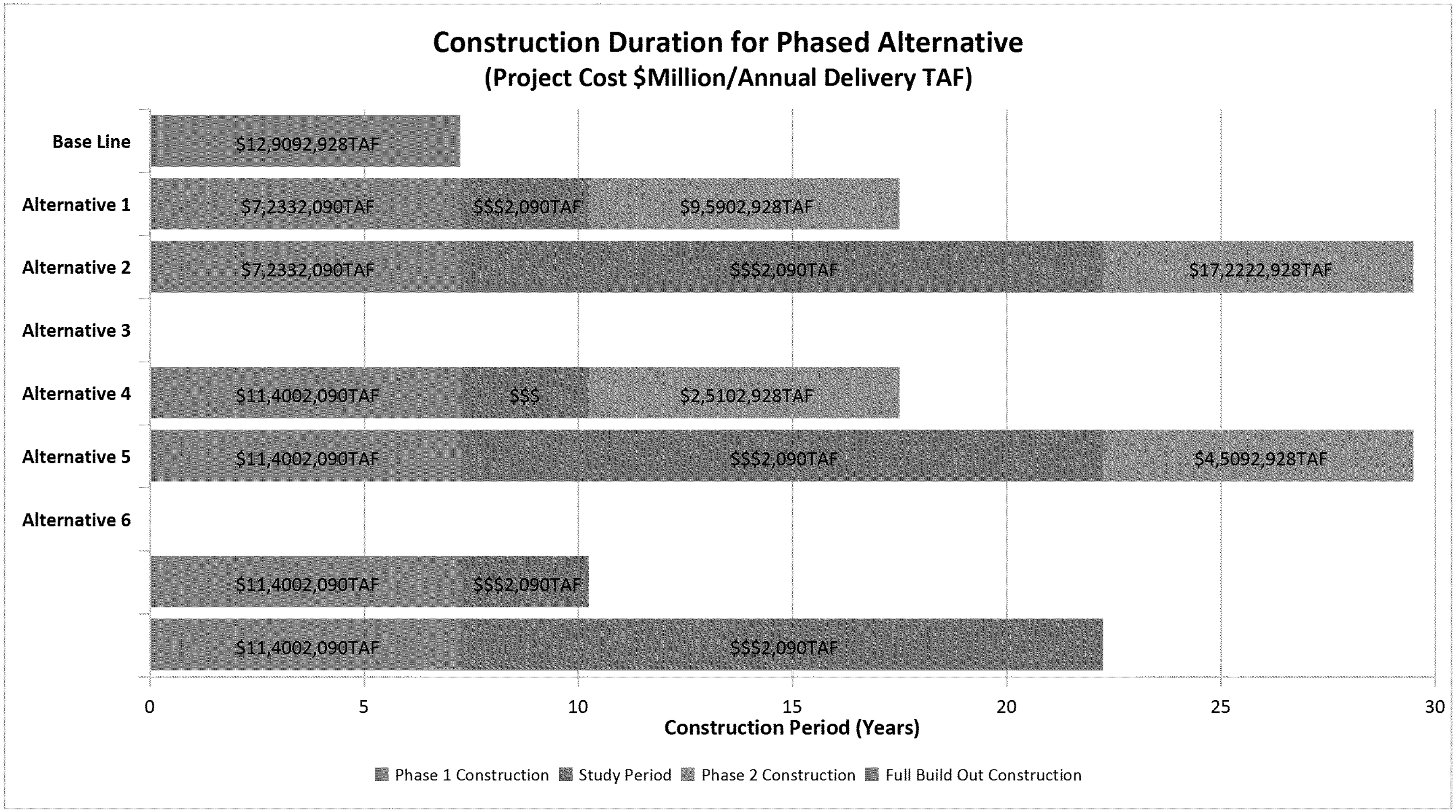


**Figure 2: Construction Duration, Construction Cost and Average Annual Yield from North Delta Intakes** (Note: The construction cost corresponds to the escalated cost at the start year of the construction phase and the project yield is based on November 2010 CALSIM Study runs. Base line: Full Build Out Alternative, Alternative 1 & 2: Construction of one tunnel connecting PTI & BTF during Phase 1 followed by either 3 or 15 year study, Alternative 3 & 4: Construction of two tunnels connecting PTI & BTF during Phase 1 followed by either 3 or 15 year study. Alternative 5: No building of Phase 2 after 3 year study, Alternative 6: No building of Phase 2 after 15 year study. Because of the associated uncertainties, no dollar values have been assigned for the post construction studies).

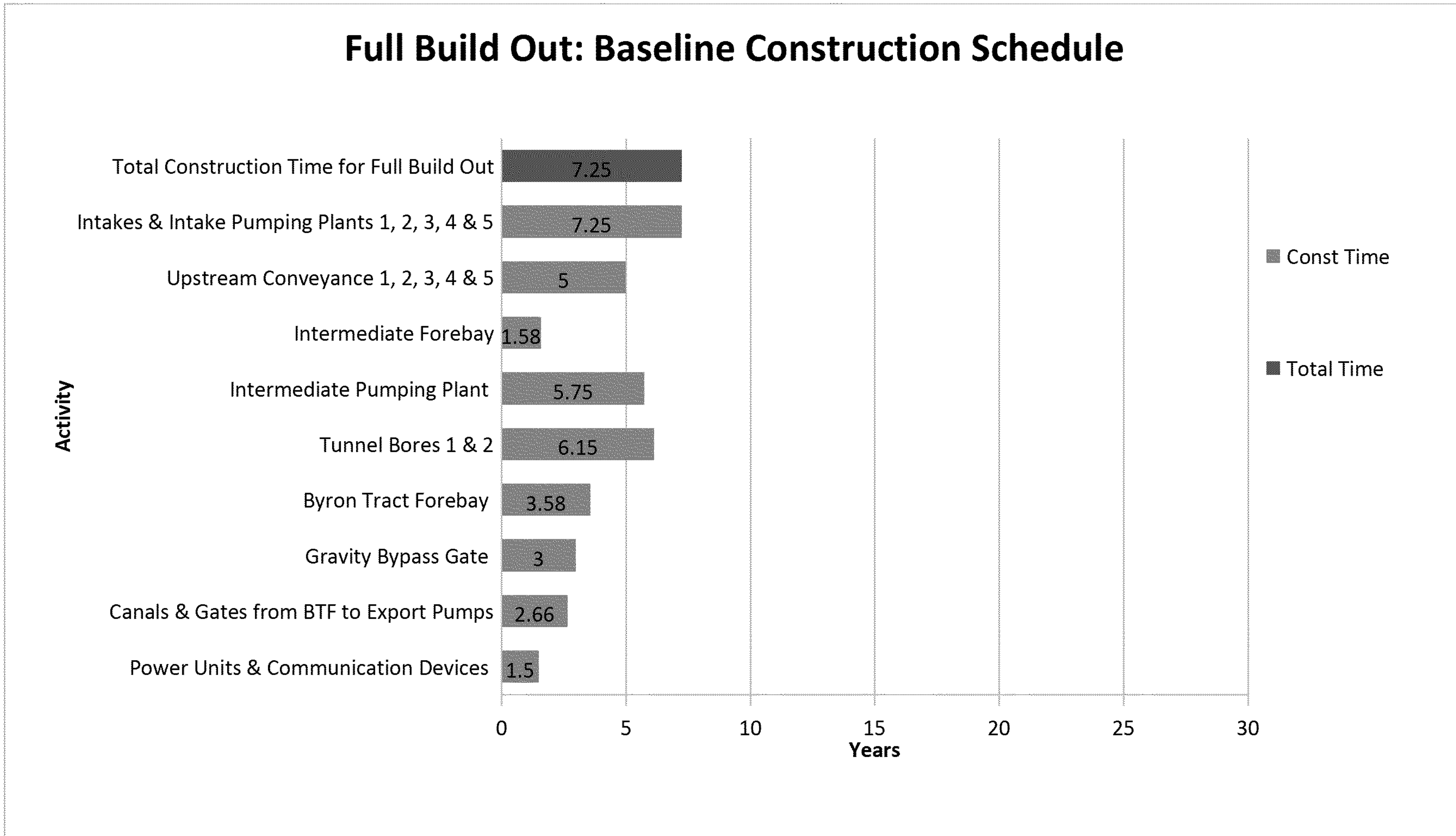


**Figure 3: Breakdown of Construction Time for Baseline Option (Full Build Out)**

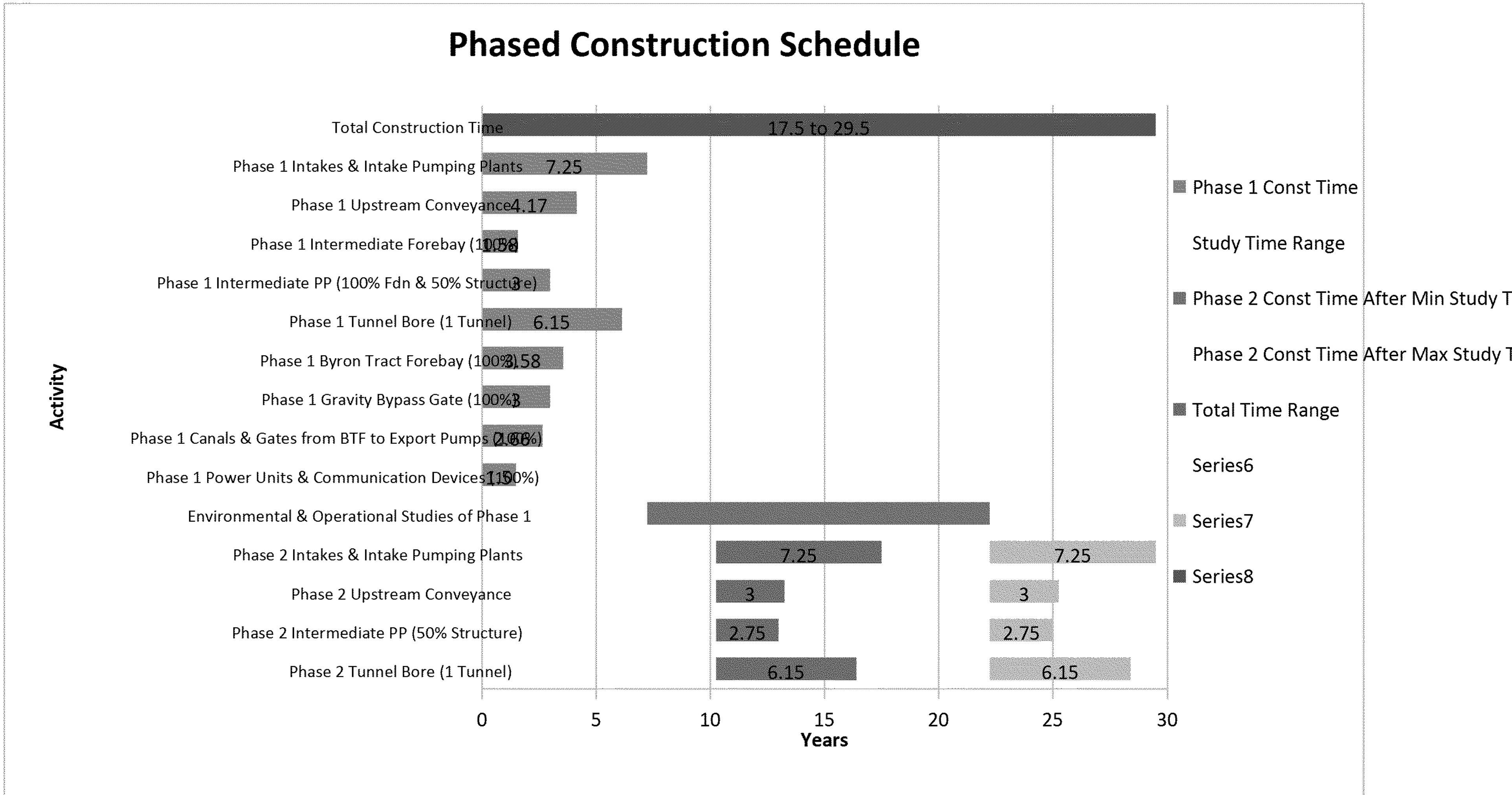


**Figure 4: Breakdown of Construction Time for Phased Construction**

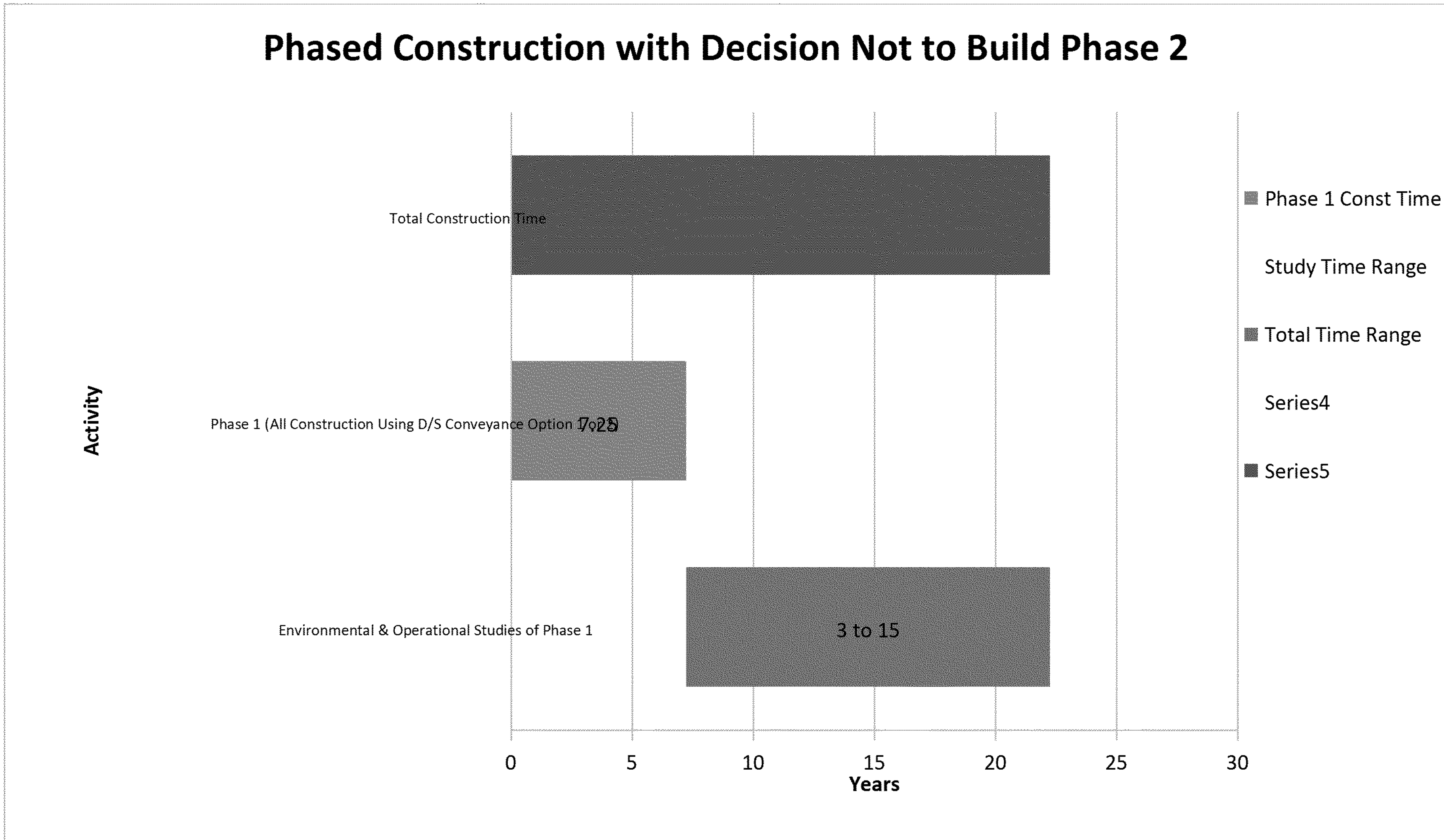


**Figure 5: Breakdown of Construction Time for "Not to build Phase 2" Option**

## ATTACHMENT 1: FIVE AGENCY PROPOSAL ON PHASING OF NORTH DELTA INTAKES FOR DHCCP

**Phasing of North Delta Facilities**

**Issue Statement:**

What is an acceptable method to reconcile (1) the desire of the applicants to secure complete authorizations for the BDCP program as a whole and (2) the desire of the permitting agencies to remain flexible about the design, engineering and operations of the north Delta diversions in order to reduce the considerable uncertainties about how they will perform without requiring multiple staged permitting processes and ESA consultations? Is the use of a proposed "phased" approach to the design, construction and operation of the north diversion facilities as described below an acceptable approach for reconciling these two objectives for purposes of shaping an effects analysis and the alternatives for the DEIS?



**Relationship to critical path items/effects analysis, and DEIS/DEIR:**

The best available science on impacts to salmonids from large screened diversions (GCID studies) indicates that there could be a large cumulative impact to salmonid survival through the diversion reach with 5 large diversions in operation. Related cumulative impacts on delta smelt are uncertain at this time. Phasing of intake construction and operations could be a key mechanism to reduce the uncertainty around the cumulative effects of intake operations and improve the overall likelihood of a viable project.

If the principals agree in concept on phasing, then this concept can be incorporated into ICF's Analytical Framework for the Effects Analysis for alternatives greater than 6,000 cfs north Diversion capacity. The analytic framework can use phasing as a mechanism to address uncertainties. This approach could allow the effects analysis to proceed, consistent with best available science, without identifying a red flag associated with cumulative impacts of screens in this reach. The details of this approach would be worked out in the Analytic Framework during the August agency review period. An analysis of the cumulative effects of intake operations, and how those effects fit into a broader suite of conservation actions with both positive and negative effects on salmonid and delta smelt survival, will be included in the Effects Analysis, in both its component parts and its roll-up.

In general, phasing of north Delta pumping capacity would be bracketed by the various capacities included in the alternatives under consideration. However, because construction impacts (both social and environmental) would be stretched out over a longer period of time, the details and structure of the NEPA/CEQA analysis might be different under a phased scenario than under a single construction scenario. How to incorporate phasing into the alternatives and what range of assumptions about performance will satisfy NEPA/CEQA needs more discussion at a technical staff level. These analyses have not yet been completed in the DEIS/DEIR, and incorporating this concept into the analytical process should not slow down the completion of the final draft.

**Proposal Overview:**



The BDCP permit and consultations would include an assumption of a full build out to total capacity (total capacity will be determined later when a preferred alternative is selected in early 2012), with a two phased approach to constructing the individual intake units based on lessons learned during the first construction phase, testing, monitoring, and adaptive management and subject to meeting cumulative reach survival and other performance criteria.

**Basic concepts:**

1. Conduct pre-construction studies/monitoring per FFTT recommendations to insure best possible design for initial phase and determine baseline conditions in the diversion reach (predator densities, salmonid survival rates, etc.). The FFTT report lists approximately 10 years of studies. While some of these studies (baseline survival monitoring, refugia optimization, etc.) would likely continue up to, and beyond, operation of the facilities, the intent is to complete the engineering design within the next few years and to have the phase one facilities constructed and ready to operate within 10 years.

2. Construct full size main tunnels and forebay to avoid second mobilization costs.

3. Construct 2 intakes (total 6,000 cfs capacity), supporting pumps and connections to tunnels for the initial phase.

4. Establish specific performance criteria and requirements (*i.e.* NMFS/DFG/FWS screening criteria, predation levels, overall survival through reach, etc.). Salmonid and delta smelt survival criteria to be developed using life-cycle modeling with consideration of overall effects of plan implementation (*e.g.* initial per screen juvenile salmon survival of 98% and cumulative reach survival of 95% as compared to baseline survival rates in the reach).

5. The DEIS alternatives could encompass a wider range of performance assumptions and phasing timing or location assumptions in order to capture a full range of potential outcomes for NEPA/CEQA purposes and preserve the ability for continued analysis through the DEIS to refine approaches.

6. Monitor performance and biological effects of operations of Phase 1 per FFTT recommendations.



7. Develop detailed study designs, including specific results criteria that would indicate the new intakes are meeting performance criteria, and commence construction of second phase once those study results are achieved. The FFFT memo includes a broad range from 3 to 15 years[6] of analysis depending on variability in hydrology. The intent is to narrow this range by developing robust study designs and statistical power analyses.

8. Develop a plan to address catastrophic Delta Island flooding by modifying north Delta pumping operations to meet emergency water supply demands until south Delta pumps are back on line.

9. Regarding intake locations, the goal and default assumption is that the project will determine the location of all intakes (for both Phase 1 and possible Phase 2) no later than the Final EIS. For now, intakes 6 and 7 will receive full analysis for biological effects, and conceptually be included in one or more alternatives over 6,000 cfs capacity in the DEIS. If analysis shows these intakes locations are

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[6] There is not agreement amongst the five agency Principals on this range; this needs further discussion and refinement.

[2] Principals agreed to have further staff analysis to expand on these “plan B” concepts.

expected to provide benefits to covered aquatic species, then they would advance into one or more of the alternatives in the draft EIS/EIR, for further review prior to the final EIS/EIR. At the final EIS/EIR stage, the applicants and lead NEPA/CEQA agencies would make the determination as to whether to include intakes 6 and/or 7 as one or two of the five proposed intake locations, exclude them from further consideration, or maintain then in the analysis as "alternative locations" to be selected through adaptive management during the initial design study period or following completion of phase 1 of the project (*i.e.* all 7 locations would be fully described in the document, and the final determination would be made after phase 1 results are analyzed).

**"Plan B" if performance criteria are not met:**[2]

10. Intensify studies to determine cause of increased mortality. If cause can be conclusively linked to a structural or other physical "flaw" in intake design or problem with location, correct that flaw or modify location for second phase of intake construction.

11. Use life-cycle analysis to re-examine the initial performance criteria, overall benefits and impacts of implementing the plan, and use adaptive management program, including an independent science review component, to recommend adjustments to improve the plan. Adjustments could be recommended to other conservation measures to offset reach specific survival impacts, or to the performance criteria themselves, or to both. Further construction would depend on the specific findings of the adaptive management program and life cycle analysis.

12. If neither 10 nor 11 above indicate that phase 2 should be built, maintain 6000 cfs capacity and optimize balance between north and south Delta exports to meet the co-equal goals of the plan.

**Proposal Variant:**

As a variant to this proposal, the project could build three intakes in Phase 1, but only operate 2. The third intake would be constructed to the back side of the levee. In-water construction associated with that intake, and any additional intakes would depend on the results of attaining performance criteria during Phase 1, per process above.

**Potential Benefits:**

1. Improvement in engineering design for second phase by learning from building first phase.

2. Avoidance of unnecessary intake construction by evaluating tradeoffs in operation between north and south Delta pumping to determine proper balance.

3. Greatly reduces the level of instream construction impacts that would result from building all 5 intakes at the same time.

4. Cost-savings by using gravity-flow from the forebay in the north Delta to south Delta pumps as a result of diverting less than 7,000 cfs from the Sacramento River (no need for new pumping station until second phase).

5. During the phasing period, total exports would be greatly improved over baseline conditions while south delta pumping would be greatly reduced. The July 2010 sizing analysis found that 6,000 cfs capacity could provide the same total average exports (north and south combined) as 15,000 cfs capacity under Steering Committee Feb. 2010 operations (6.1 maf), while resulting in approximately 1 million acf reduction in average annual south Delta exports as compared to baseline (OCAP RPAs) conditions. These relationships hold under the 2025 climate change scenario and the “increased outflow” scenario included in the July 2010 sizing analysis.

ATTACHMENT 2

## List of Workshop Participants

### Construction Phasing of DHCCP Intakes

**October 12, 2011**
**9:00 a.m. – 4:00 p.m.**

**Attendees:** Attendee List

| Name | Organization | Phone | email |
|---|---|---|---|
| Ganesh Pandey | DWR/DOE | 916 653 5918 | gPandey@water.ca.gov |
| Heather Webb | BDFWO | 916 930-5653 | heather_webb@fws.gov |
| Dan Meier | USFWS | 916-414-6725 | Dan_Meier@fws.gov |
| Jim Peddy | DWR / DOE | 916 671 4178 | jimpeddy@me.com |
| SERGIO VALLES | MWDI | (714)-606-2451 | SVALLES@MWDH2O.com |
| Dennis Dorratcague | MWH | 425 896-6904 | dennis.dorratcague@mwhglobal.com |
| ALAN STROPPINI | USBR | 916 978-5376 | astroppini@usbr.gov |
| George Heise | CDFG | 916-445-3399 | gheise@dfg.ca.gov |
| BOB GATTON | CH2M HILL | 425-453-5000 | bob.gatton@CH2m.com |
| Praba Pirabarooban | DWR/DOE | 916-651 2960 | spirabar@water.ca.gov |
| Gordon Enas | DWR/DOE | 916-653-7589 | enas@water.ca.gov |
| MIKE TUCKER | NMFS | 916-~~[illegible]~~ | MICHAEL.TUCKER@NOAA.GOV |
| | | 930-3604 | |
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**Additional attendees included: George Heise (Department of Fish and Game) and Mike Hoover (US Fish and Wildlife Service)**

ATTACHMENT 3

## October 14, 2011 Workshop Scope
## Phased Construction of North Delta Intake Facilities

The July 2011 technical memorandum by the Bay-Delta Conservation Plan's Fish Facilities Technical Team (FFTT) includes a proposal to develop a phased approach to implementing the DHCCP's North Delta intake facilities. In order for the project sponsors to include this approach as a potential alternative in the EIR/EIS, there is a need for additional scope and schedule definition. To that end DWR would like to have a one day workshop to explore in more detail the scope and schedule of this proposal as compared to the existing "full build out" alternative.

The first phase of the workshop will be to develop a clear statement of the scope and schedule for the "full build out" project. The purpose here would be to have all workshop participants agree to the proposed schedule.

The next phase of the workshop would be to develop an item by item, thorough review of the phased approach so there is no misunderstanding of the proposal. The emphasis will be on taking proposal as it stands and converting it into a more concise alternative description for potential inclusion in the EIR/EIS process. Although which intakes would initially be constructed is relatively important and the scope of the downstream conveyance facilities is of general interest, the key for this investigation is the schedule and scope of all the required engineering studies to support the phased approach (i.e., hydraulic modeling, river morphology, etc…).

The scope of the engineering studies should also be able to address the following issues:

**Potential for stranded costs due to phased construction.**

**Potential for stranded costs due to full build out alternative.**

**Reliability of south Delta facilities during a flood or seismic event as it relates to the phased approach.**

**Pumping constraints imposed on the intakes due to new BDCP operation rules.**

**Discussion and clarification of the proposed facilities in Phase 1 and the proposed studies to inform the design of Phase 2 facilities.**

**Overall construction cost and schedule.**

ATTACHMENT 4 (A)

Pre-construction, Pre-design Near-term studies, and Post-construction Long-Term Monitoring Studies Recommended by FFTT (2011)

**Table 1: List of Near-Term Aquatic Studies Needed Prior to Diversion Structure Construction to Reduce Key Uncertainties.**

| Study Number * | Study Name | Research Needs Prior to Construction | Study or Studies Needed | Study Purpose | Study Timeframe | Required Completion Time |
|---|---|---|---|---|---|---|
| 1 | Site Locations Lab Study | Evaluation of proposed screen sites and design features (river flow patterns, transition walls, screen geometry, baffle geometry, eddy locations, macro-refugia, and boundary effects on sweeping velocity) | Physical hydraulic model(s). If site locations are significantly different in terms of river flow conditions or structure geometry, then more than one physical model study is needed. | Physical model provides ability to optimize hydraulics and sedimentation in the chosen river reach. The screening structure and river reach can be modified as needed. Differences between the average channel velocity in the river and sweeping velocity adjacent to the screen face will be identified. Neutrally-buoyant particles will be tracked to provide information on larval fish movement. | Expected duration 6-12 months per model study depending on model scope of work and lab availability | Prior to final design (model can be completed concurrently with "Refugia Lab Study") |
| 2 | Site Locations Numerical Study | Evaluation of tidal effects and withdrawals on flow conditions at screening locations | Computational fluid dynamics model | Numerical model will provide information on how tidal changes and flow withdrawals affect flow conditions and sweeping velocities at screening locations. Results can be used in "Site Locations Lab Study" to set boundary conditions and validate physical model results. | Expected duration 6 months depending on model detail and complexity | Prior to final design |
| 3 | Refugia Lab Study | Design of refugia areas (macro, micro, and base refugia) | Physical hydraulic model | Physical model provides ability to measure hydraulics and observe fish behavior in a controlled environment. Size/shape of refugia areas can be modified to optimize fish usage. Predators can be added to examine predation behavior near refugia. | Expected duration 6-9 months depending on model scope of work and lab availability | Prior to final design (model can be completed concurrently with "Site Locations Lab Study") |
| 4 | Refugia Field Study | Examination of refugia at future fish screens. | Field evaluation of future facilities** | Field evaluation of fish screening facilities using fish refugia will provide important information on their effectiveness and areas for improvement. | 1 year study | Prior to final design |
| 5 | Predator Habitat Locations | Examine predator habitat locations | Field evaluation of similar facilities*** | Identify predator habitat areas at other facilities. | 1-2 year study | Prior to final design |
| 6 | Predator Reduction Methods | Examine predation reduction methods | Literature search and potential field evaluation of similar facilities*** | Identify alternatives for reducing predator habitat. | 1 year study | Prior to final design |

| | | | | | | |
|---|---|---|---|---|---|---|
| 7 | Flow Profiling Field Study | Characterize the water velocity distribution at river transects within the proposed intake reaches for differing river flow conditions. | Field study to measure water velocity distribution across river transects utilizing acoustic Doppler current profiler. Effort to define velocity conditions at channel boundary will be made. | Differences between the average channel velocity in the river and sweeping velocity adjacent to the screen locations need to be identified in order to properly design the screen for sweeping velocity. Water velocity distributions in intake reaches will identify how hydraulics change with flow rate and tidal cycle. | 1 year study | Prior to final design |
| 8 | Deep Water Screens Study | Effects of deep water screens on hydraulic performance | Computational fluid dynamics model | Proposed screen depth is large. Unique baffling systems and/or creative design elements may be required to address vertical velocity variations at the screen face. | Expected duration 6 months depending on model detail and complexity | Prior to final design |
| 9 | Baseline Predator Density and Distribution | Baseline predator density and distribution | Didson camera or other technology and/or acoustic telemetry at 2-3 proposed screen locations; velocity evaluation of eddy zones if needed | Collect baseline predator density and location data for comparison to future post-construction predator data | Important to start studies as soon as possible to collect multiple data sets before construction begins. | Prior to construction |
| 10 | Baseline Juvenile Salmon Survival Rates | Baseline survival rates of juvenile salmon | Mark and recapture studies, acoustic telemetry studies, and/or fyke net studies in proposed intake river reaches and control river reaches. Need to collect baseline data at 2-3 proposed screen locations and 2-3 control reaches. | Collect baseline survival data for comparison to future post-construction survival data | Important to start studies as soon as possible to collect multiple data sets before construction begins. | Prior to construction |
| 11 | Baseline Fish Surveys | Baseline density and distribution for covered fish species. Targeting all life stages for delta and longfin smelt. | Literature search, trawling, trapping, and beach seining | Enhance current baseline knowledge of covered species through the collection of additional data focused on determining delta and longfin smelt density and distribution within the reach of the proposed intake locations. In addition collect data directly upstream and downstream of the intakes and in close proximity to sloughs and channels. | On-going study to occur during months when delta and longfin smelt are expected to occur in the area. Important to start studies as soon as possible to capture seasonal data. | Prior to construction |

NOTES: * No priority is implied by the order of the studies described in the table. All studies are necessary to meet project goals.
** Future facilities with refugia will include Red Bluff Diversion and Bella Vista
*** Similar facilities include Freeport, RD108, Sutter Mutual, Patterson Irrigation District, Glenn Colusa Irrigation District, or other suitable screen sites
****Additional pre- and post construction studies/surveys will be needed for terrestrial species

ATTACHMENT 4 (B)

**Table 2 List of Aquatic Studies and Monitoring Needs After Diversion Structure Construction to Ensure Screens are Meeting Performance Criteria**

| Study Number * | Study Name | Type of Criteria | Study or Monitoring Needs After Construction | Study or Monitoring Needed | Study or Monitoring Purpose | Study Timeframe*** | Benefits Achieved by Phasing Construction** |
|---|---|---|---|---|---|---|---|
| 1 | Hydraulic Screen Evaluations to Set Baffles | Hydraulic | Post-construction hydraulic evaluation of screen performance to set baffles | Hydraulic field evaluations to measure velocities over a designated grid in front of each screen panel. Repeat as necessary to set initial baffle positions. | Establish initial baffle settings and confirm compliance with design criteria. | Estimated 3 month study (conducted close to maximum diversion rate). | May indicate need to improve design of baffle system, resize screens, or modify operations. |
| 2 | Long-term Hydraulic Screen Evaluations | Hydraulic | Long-term hydraulic evaluation of screen performance | Hydraulic field evaluations | Ensure operational criteria are within acceptable tolerances over the long term. Provide changes to baffle settings as needed to accommodate changes in river conditions and diversion rates. | Monitor long-term compliance with criteria. Frequency to be determined, initially annually. | N/A |
| 3 | Periodic Visual Inspections | Hydraulic | Identify effectiveness of cleaning mechanism and screen integrity. | Visual inspections (diver and/or camera). | Determine whether cleaning mechanism is effective at protecting the structural integrity of the screen and maintaining uniform flow distribution through the screen. Adjust cleaning intervals as needed to meet requirements. | 1 year post-construction study, then periodic evaluation over life of project. | May indicate need to improve design of cleaning mechanism; provides information on required cleaning intervals |
| 4 | Velocity Measurement Evaluations | Hydraulic/ Biological | Determine sweeping velocities at the screen facility, and in front of and within refugia areas | Hydraulic field evaluation of sweeping velocities at the screen facility and in front of and within refugia areas over a range of flow conditions | Determine if exposure time is within design criteria for operating flow conditions. Determine if refugia areas are sufficient to meet fish exposure criteria and provide a range of conditions suitable for fish to inhabit the refugia. | 1 year post-construction study, then ongoing evaluation. | Refugia areas may need to be modified. Potential to modify operational triggers. |
| 5 | Refugia Effectiveness | Biological | Effectiveness of refugia areas | Didson camera or other technology | Observe fish behavior in refugia areas to ensure that refugia is successful at minimizing screen impingement and near-screen predation. | 2 year post-construction study, then ongoing evaluations to determine if refugia should be modified. | Refugia areas may need to be added, removed, or modified. |
| 6 | Sediment Management | Hydraulic | Examine sediment deposition in front of screen base and | Sonar imaging, acoustic bathymetry, and/or divers | Evaluate effectiveness of sediment management devices in minimizing | 2 year post-construction study, then ongoing | May need to improve sediment management strategies or |

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| | | | behind screens | | problematic sediment deposition. | evaluations. | increase sill height. |
| 7 | Screen Impingement | Biological | Evaluation of screen impingement | Didson camera or other technology and/or divers to observe fish activity at screen face. Marked release/recapture to evaluate injury rate. Pull screens to evaluate screen condition. | Observe fish behavior at screen face to ensure that impingement does not occur. | 2 year post-construction study (provided varied river flows and diversion rates). | May indicate need to improve design of baffle system, resize screens, add refugia, or modify operations. |
| 8 | Screen Entrainment | Biological | Evaluation of screen entrainment | Fyke net study behind screens. Pull screens to evaluate screen condition. | Identify species/size of fish passing through the screen. | 2 year post-construction study (provided varied river flows and diversion rates) then ongoing evaluations. | May indicate that smaller screen openings are preferred. |
| 9 | Post-Construction Predator Density and Distribution | Biological | Evaluation of predator density and distribution | Didson camera, electrofishing, or other technology and/or acoustic telemetry; velocity evaluation of eddy zones if needed | Determine density and location of predators. Identify ways to reduce predation at the facilities. | 3 year post-construction study (provided varied river flows and sufficient predator populations). | Designs can be modified to minimize predator holding areas. |
| 10 | Post-Construction Juvenile Salmon Survival Rates | Biological | Post-construction survival rates of juvenile salmon | Mark and recapture studies, acoustic telemetry studies, and/or fyke net studies in intake river reaches and control river reaches | Collect post-construction survival data for comparison to baseline survival data. Identify the change in survival rates due to construction/operation of the intakes. | 3 year post-construction study (provided varied river flows and diversion rates). | May indicate need to improve design, resize screens, or modify operations. |
| 11 | Post-Construction Fish Surveys | Biological | Post-construction survey for density and distribution of covered fish species. | Trawling, trapping, and beach seining | Collect post-construction survey data for density and distribution of covered fish species for all life stages. Compare to baseline catch data. Identify potential changes due to construction of intakes. | Ongoing evaluations. | NA |

NOTES: * No priority is implied by the order of the studies described in the table. All studies are necessary to meet project goals.

** Modifications to the design and/or operation of the intake facilities identified during post-construction evaluations can be applied to existing and future intake facilities.

*** While many of these monitoring activities are expected to continue beyond any phasing period for project construction, the "years post construction" are intended to indicate the likely time period necessary (under optimal study conditions) to ensure the facilities are meeting performance criteria, and to determine necessary design improvements for subsequently constructed intake facilities.

****Additional pre- and post construction studies/surveys will be needed for terrestrial species